the maximum size of *Terrapene carolina putnami* from Florida (Table 1).

TABLE 1

Maximum Shell Length (in mm) of Fossil and Recent *Terrapene*

Species	Locality	Age	Length*	Reference
Terrapene sp.	Lewisville site Denton Co., Texas	Pleistocene Sangamon	269.0 (plastron)	This paper
Terrapene illanensis	Lone Tree Arroyo Meade Co., Kansas	Pleistocene Sangamon	232.0 ±	Oelrich (1953)
Terrapene canaliculata	Friesenhahn Cave, Bexar Co., Texas	Pleistocene Wisconsin	208.0	Milstead (1956)
Terrapene marnocki	San Diego Co., Texas	Pleistocene *Equus* beds	215.0	Hay (1908)
Terrapene putnami	Hillsboro Co., Florida	Pleistocene Late	320.0 ±	Hay (1908)
Terrapene carolina major	Florida	Recent	216.0	Auffenberg (1958)

* Lengths are of carapace, except for Lewisville plastron.

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PLEISTOCENE LIZARDS FROM NEW PROVIDENCE

Richard Etheridge

Late in the Pleistocene the remains of vertebrate animals accumulated in limestone caves and sinkholes on many islands of the West Indies. Their age is not known exactly, but they are probably not older than late Pleistocene and some of them appear to be only a few thousand years old. Lizard remains have been reported from Cuba (Koopman and Ruibal, 1955), Jamaica (Hecht, 1951), Hispaniola (Etheridge, 1965), Puerto Rico (Barbour, 1919), and Barbuda (Auffenberg, 1958; Etheridge, 1964). These faunas include species that are now extinct, species that grew to a larger size than their living descendants or nearest living relatives, and species that live elsewhere today but are now extinct at the fossil localities. A small collection of fossil lizards from New Providence Island, Bahamas, indicates that this island experienced a similar pattern of extinction and gigantism.

The fossils reported here were removed from a sinkhole in oolitic limestone near the western end of New Providence. A large banana tree growing in the sink led to the locality designation of Banana Hole. The site was discovered during the summer of 1958 by Dr. J. C. Dickinson, Jr., of the University of Florida, who, with the assistance of Dr. Walter Auffenberg, removed a large number of bones at this time and again in 1959 and 1960. A detailed description of the site has been given by Brodkorb (1959) in his account of the Banana Hole bird fossils. On the basis of geological evidence and the fossil avifauna he assigned the deposit to the pre-Pamlico portion of the Wisconsin glacial stage of the Pleistocene.

All museum numbers refer to specimens in the vertebrate paleontology collections of the University of Florida.

Family Gekkonidae

1. *Tarentola americana* (Gray) 1831

Remains of a large gecko are indistinguishable from the bones of modern Cuban specimens of *Tarentola americana*. The characteristics which distinguish this species from other West Indian geckos have been given by Hecht (1951) and Etheridge (1964, 1965).

The largest fossil, a dentary that measures 12.5 mm along its tooth row, is estimated to have come from an animal about 88 mm in snout-vent length. The largest Bahaman specimen known to me is a male from Exuma Island, 86 mm snout-vent length. Loveridge (1944) recorded a Cuban specimen 133 mm snout-vent length.

Tarentola americana now occurs throughout most of Cuba and on Andros Island to the southwest of New Providence and on Exuma and Ragged Islands to the southeast. It is not known to have lived on New Providence in modern times. Late Pleistocene fossils of *T. americana* have been reported from a cave in Camaguey, Cuba (Koopman and Ruibal, 1951).

Referred Material. Dentaries 10179 (2), 10180 (8); maxillae 10181 (3).

Family Iguanidae

2. *Anolis carolinensis* Voigt 1832

Anoles are by far the most abundant lizards in Banana Hole. About 150 fossils are indistinguishable from bones of modern *Anolis carolinensis* from New Providence. The osteological characteristics of the species have been described by Auffenberg (1956). The largest element is a dentary that measures 9.8 mm along its tooth row and is estimated to have come from an animal about 58 mm in snout-vent length.

Anolis carolinensis smaragdinus now occurs on New Providence, on other islands of the Great Bahama Bank, and on Bimini. Oliver (1948) gives the maximum snout-vent length of the race on Bimini as 64.1 mm. On the basis of 117 specimens from Long Island, Eleuthra, New Providence, and Andros, now in the University of Michigan Museum of Zoology, the maximum size throughout the remainder of its range is about 59 mm, or about that of the New Providence fossils. The maximum size of other members of the *carolinensis* group (*allisoni, brunneus, carolinensis, fairchildi, longiceps, maynardi, porcatus*) exceeds that of *smaragdinus,* ranging from about 64 to 75 mm (Conant, 1958; Ruibal, 1964; personal measurements of specimens in the UMMZ).

Anolis carolinensis has been recovered from deposits of Illinoian, Wisconsin, and Post-Wisconsin age in Florida (Auffenberg, 1956; Holman, 1958, 1959a, 1959b). The New Providence fossils represent the first record of the species in the West Indian Pleistocene.

Referred Material. Dentaries 10140 (41), 10141 (21), 10142 (32),

articular 10143; maxillae 10144 (4), parietal 10145, pelves 10146 (3); frontals 10147 (3), 10148 (35).

3. *Anolis distichus* Cope 1861

Ninety jaws are referred to *Anolis distichus* because of their sharply pointed, tricuspid tooth crowns. The teeth of other Bahaman anoles are relatively wider at their base and their cusps, especially the median cusp, are relatively more obtusely pointed. Twenty-six frontals are referred to this species because of their markedly concave upper surface (flat or shallowly concave in other Bahaman anoles). In all major features the fossils are identical with modern skeletons of *Anolis distichus* from New Providence.

The largest specimen is a dentary that measures 7.2 mm along its tooth row and is estimated to have come from an animal about 49 mm in snout-vent length. On the basis of 20 specimens from Bimini (Oliver, 1948) and my measurements of 106 specimens in the UMMZ from New Providence, Andros, Eleuthra, Ragged Island, Long Island, and Cat Island, the maximum snout-vent length of the species in the Bahamas ranges from 48 mm on New Providence, Andros, and Cat Island to 53 mm on Eleuthra. On Hispaniola the species reaches a maximum snout-vent length of about 50 mm.

The New Providence fossils of *Anolis distichus* represent the first record of the species from the Pleistocene. It was absent from a large Pleistocene cave fauna at Cerro de San Francisco in western Dominican Republic, where *A. distichus* occurs today and would reasonably be expected among the fossils, had it actually lived there (Etheridge, 1965).

Referred Material. Dentaries 2999 (9), 10137 (62); maxillae 10135, 10136 (17), 10139; frontals 10138 (26).

4. *Anolis sagrei* Dúmeril and Bibron 1837

By far the most abundant lizard species in the Banana Hole fauna is *Anolis sagrei;* 375 jaws and 183 other elements are referred to the species. The jaws may be distinguished from other Bahaman anoles by the shape of their tooth crowns, slightly more slender than those of *carolinensis,* with the cusps not as sharply pointed as those of *distichus.* The frontal bones of sagrei are not as distinctly rugose nor is the interorbital width as great as in *carolinensis,* and they are not markedly concave above as in *distichus.*

The largest specimen is a dentary, measuring 11.0 mm along its tooth row. It is estimated to have come from an animal about 77 mm in snout-vent length. On the basis of 226 specimens in the UMMZ from Andros, Abaco, Eleuthra, Bimini, Crooked Island, Ragged Island, Long Island, New Providence, and Cat Island, the maximum size of *sagrei* in the Bahamas ranges from 54 mm snout-vent length on New Providence and Andros to 61 mm on Long Island. On Jamaica the species reaches a maximum snout-vent length of 55 mm (Lynn and Grant, 1940), and on Cuba 67 mm (Ruibal, 1964). On the mainland, *A. sagrei* attains a maximum snout-vent length of 60 mm in Florida (Duellman and Schwartz, 1958), 68 mm in British Honduras (Neill and Allen, 1962) and 64 mm in Yucatan and Quintana Roo (26 specimens in the UMMZ). Thus, the Banana Hole fossils of *Anolis sagrei* exceed in snout-vent length the present New Providence population by 23 mm, and the largest modern specimens (British Honduras) by 9 mm.

The Banana Hole specimens represent the first known fossils of *Anolis sagrei.*

Referred Material. Dentaries 10149 (134), 10150 (112), 10151 (32); maxillae 10152 (44), 10153 (45), 10154 (7); articulated mandible 10155; articulars 10156 (4), parietals 10157 (9); frontals 10161 (4), 10162 (145); pterygoid 10159; basale 10160 (4); caudal vertebrae 10163 (12).

5. *Leiocephalus carinatus* Gray 1827

Nineteen jaws, 3 frontals, and a single intact autotomic caudal vertebra are indistinguishable from those of modern *Leiocephalus carinatus.* The distinguishing osteological characteristics of the genus and of most of the species have been given by Estes (1963) and Etheridge (1964, 1965).

The largest specimen is a maxilla measuring 11.0 mm along its tooth row and estimated to have come from an animal about 110 mm in snout-vent length. The present population on New Providence is referred to the subspecies *L. carinatus virescens.* According to Rabb (unpublished doctoral thesis, University of Michigan) *Leiocephalus carinatus* in the Bahamas has a range of maximum snout-vent length from 73 mm on Castle Island to 116 mm on New Providence. The largest living race, *L. carinatus microcyon* on the Isle of Pines, attains a maximum of 130 mm snout-vent length (Schwartz, 1959).

Leiocephalus personatus and an extinct species, *L. apertosulcus,* have been reported from the Late Pleistocene of Hispaniola (Etheridge, 1965), and another extinct form, *L. cuneus,* has been described from Barbuda (Etheridge, 1964). An undescribed extinct species also occurred on Jamaica (unpublished data).

Referred Material. Dentaries 10175 (11); maxillae 10173, 10176 (6); frontals 10177 (3); pelves 10178 (3); caudal vertebra 10174.

6. *Cyclura* sp. indet.

Several fragmentary limb bones, girdle elements, vertebrae and jaws are referred to *Cyclura* because of their large size and their possession of certain structural peculiarities of that genus. A single premaxilla contains two simply pointed teeth and seven vacant alveoli. The superficial surface of the rostral part is pierced by nine large foramina. The presence of a high number of foramina (six or more) appears to be characteristic of the genus *Cyclura;* they are fewer in number or absent in other large iguanine genera, e.g. *Iguana, Conolophus, Amblyrhynchus, Ctenosaura.* The rostral part of the premaxilla is 14.6 mm wide and is estimated to have come from a skull at least 100 mm long from the tip of the snout to the occipital condyle, or from an animal about 530 mm in snout-vent length.

A number of jaw fragments are from different regions of the dentary and maxilla. Teeth from the middle and posterior regions have their crowns strongly compressed laterally and flared in an anterior-posterior direction, with a multicuspid cutting edge; a large median cusp flanked by two or three smaller cusps in front and one or two behind. Teeth from more anterior regions are strongly tricuspid, and those from the extreme anterior ends of the jaws, like those of the premaxilla, are simply pointed. The fossils have been compared with skeletons of young and adult modern *C. macleayi, C. rileyi, C. ricordi, C. cornuta, C. baelopha* and *C. cristata,* and with fossils of the extinct *C. portoricensis.* Their teeth are of the same general type as described for the fossils; however, there appears to be considerable individual variation and ontogenetic change in the number of cusps and the symmetry of their arrangement. For the present, tooth crown structure does not seem to be a usable character for identifying species of *Cyclura,* although it will serve to distinguish *Cyclura* from most other large

iguanines. In *Amblyrhynchus* and *Conolophus* almost all the marginal teeth, including those of the premaxilla, are strongly tricuspid; four- or five-cuspid teeth occur only as uncommon variants. The cutting edges of the teeth of *Iguana* are serrate, a condition approached in *Cyclura* only in very large individuals of *C. cornuta.*

Two body vertebrae and one first sacral vertebra have the well developed zygosphenes and zygantra characteristic of all of the large iguanines. The largest is estimated to have come from an animal about 460 mm snout-vent length. A dissociated ilium has an acetabular diameter of 17.7 mm and is estimated to have come from an animal about 345 mm in snout-vent length. Because it had become freely dissociated from the other pelvic elements it is presumably from an individual that had not attained maximum size.

At the present time *Cyclura* does not occur on New Providence. *C. baelopha* occupies Andros Island to the west, *C. inornata* lives on Eleuthra and Cat Island to the east, and *C. cristata* on Exuma to the south.

Referred Material. Dentary 10193; maxilla 10194; jaw fragments 10195 (6); premaxilla 2997; ilium 10191; ulna 10192; body vertebrae 10196 (2); sacral vertebra 10198; caudal vertebrae 10197 (5).

Family Teiidae

7. *Ameiva thoracica* Cope 1862

A small number of cranial, vertebral, and pelvic elements are indistinguishable from those of modern *Ameiva thoracica* from New Providence. The only complete jaw, a dentary, measures 9.5 mm along its tooth row and is estimated to have come from an animal about 75 mm in snout-vent length. Several pelves in which the components are ankylosed are presumably from individuals near maximum size. The largest of these has an acetabular diameter of 2.8 mm and is estimated to have come from an animal about 70 mm in snout-vent length. The maximum size of *A. thoracica* varies considerably among the islands, reaching a maximum of 120 mm on Eleuthra. Modern individuals from New Providence are considerably smaller, exceeding the maximum size estimated for the fossils by only a few millimeters.

Ameiva thoracica is widespread in the northern and central islands of the Bahamas today. *A. maynardi* of Great Inagua, a close

ally of the Hispaniolan *A. lineolata,* is the only other modern Bahaman species. Late Pleistocene cave fossils of *A. chrysolaema* and *A. taeniura* are known from Hispaniola (Etheridge, 1965) and of *A. griswoldi* from Barbuda (Auffenberg, 1958; Etheridge, 1964).

Referred Material. Dentaries 10186 (2); maxillae 10187 (2); frontals 10182 (2); pelves 10183 (2), 10185 (2); vertebrae 10184 (4).

DISCUSSION

Exclusive of bats, most small animal remains found in West Indian sinkholes and caves probably accumulated as the regurgitated pellets of owls that lived in the caves (Anthony, 1919; Miller, 1929; Hecht, 1951; Etheridge, 1965). Brodkorb (1959) reported two barn owls (*Tyto pollens* and *T. alba*), a screech owl (*Otus providentiae*), and a pygmy owl (*Glaucidium dickinsoni)* as fossils in Banana Hole. To the extent that these owls were selective in their feeding, the Banana Hole small animal fossils form a biased sample of the fauna of New Providence at that time. Bones of larger animals such as iguanas and the owls themselves are probably from animals that lived in the caves.

Two lizard types living on New Providence today are not among the Banana Hole fossils, i.e. *Anolis angusticeps* and several species of the small gecko genus *Sphaerodactylus.* For different reasons their absence among the fossils probably should not be considered evidence of their absence on New Providence at the time the Banana Hole fossils accumulated. All of the sphaerodactyls are small; the largest, *S. anthracinus,* reaches a maximum snout-vent length of only 39 mm. The genus has not been found in any other West Indian cave deposit, and because of its small size and the method of fossil accumulation it may not reasonably be expected (Etheridge, 1965). *Anolis angusticeps* reaches a maximum snout-vent length of about 54 mm. There is no reason to believe that it is not subject to owl predation as are other anoles. However, *A. angusticeps* is nowhere abundant in the Bahamas, being far outnumbered by other anoles that live on the same islands. Oliver (1948) believes that its rarity in the Bahamas is due to its highly restricted niche, the upper branches of light-barked trees such as *Ficus* at heights of 6 to 25 feet. Rarity, rather than complete absence, may account for its absence among the Banana Hole lizard fossils.

The past and present lizard faunas of New Providence, together with the present lizard faunas of most other Bahaman islands to the north and east of the Caicos Passage, clearly have their closest ties with Cuba. Of six identifiable species in Banana Hole four also live on Cuba, *Tarentola americana, Anolis carolinensis, Anolis sagrei* and *Leiocephalus carinatus;* and a fifth, *Ameiva thoracica,* is very closely allied to a Cuban form, *A. auberi. Anolis distichus* is alone in its ties to Hispaniola. Of the modern species not found as fossils *Anolis angusticeps* also occurs on Cuba and the sphaerodactyls, though in need of taxonomic study, appear to be most closely allied to Cuban forms.

The conclusions to be drawn from the Banana Hole lizard fauna are very similar to those of Brodkorb (1959) based on the fossil birds: the New Providence fauna was at one time richer than it is today, and then, as now, the faunal ties of New Providence were primarily with Cuba and secondarily with Hispaniola.

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